Volume 20 March, 1934 *Number 3*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Electric Motor Lubrication

Protection Against Dust and Water

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

Protect the Bearing
and you
Protect the Motor

● The efficiency of an electric motor will depend largely upon the degree to which its bearings are protected by lubrication. They are the only wearing elements involved; furthermore, they serve to maintain alignment of the rotor shaft. This, however, can only be assured provided abnormal wear is not allowed to occur. Obviously, excessive wear would lead to possible contact between the armature and field coils. Hence the importance of lubrication as an adjunct in preventing wear.

● For this reason, motor builders, lubricating engineers and the operating personnel in any plant must thoroughly appreciate the importance of lubrication, and the value of careful study of lubricant characteristics with respect to bearing construction and operating conditions.

● In average service motor bearing lubrication will rarely give any trouble. On the other hand, an installation subjected to abnormal temperatures, as for example, in an economizer housing, an airplane beacon, or adjacent to a kiln; or exposed to dust and dirt, as in a flour or cement mill, may easily prove an exception to the rule. Such conditions require an intimate knowledge of the construction of the various types of bearings customarily used, improved methods of sealing, and the extent to which oils or greases can be applied in accordance with operating requirements.

THE TEXAS COMPANY

Texaco Petroleum Products

LUBRICATION

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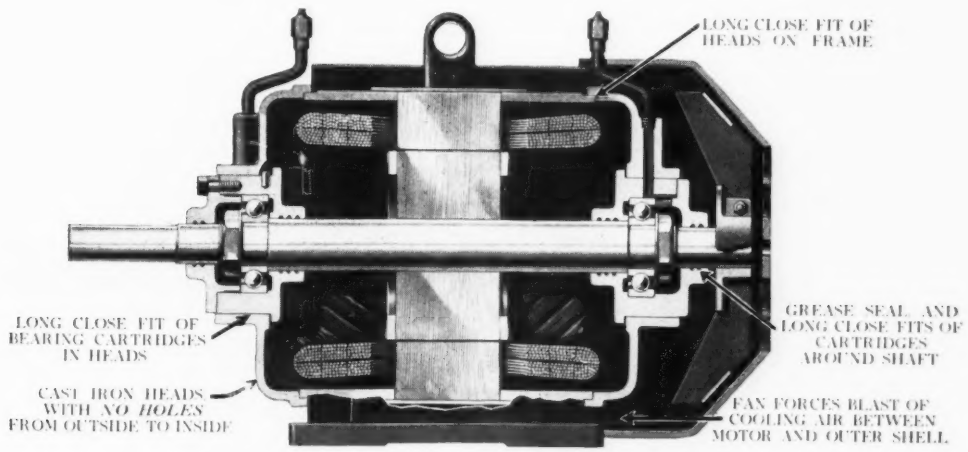
Electric Motor Lubrication

Protection Against Dust and Water

PROTECTION of bearings and windings of the electric motor when it is called upon to function in the presence of excessive water, dust, abrasive materials or acid fumes, has received most careful attention from motor manufacturers during the past few years. The economy of the installation is to be justified. Any failure of bearings due to impaired lubrication, or contact of the windings with water or dust may inflate repair costs to such an extent as to discourage the user against further installations.



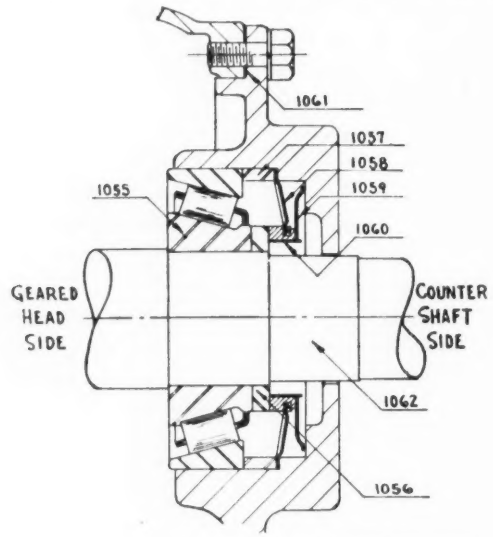
Courtesy of The Louis Allis Company

Fig. 1—Showing the Louis Allis sealed type totally enclosed, fan cooled motor. Note that the bearing chambers are within the enclosure, thus utilizing the lubricant seal and close fit of the bearing cartridges around the shaft to exclude foreign matter.

adaptability of the unit drive in power transmission to virtually every phase of industry has been largely responsible for this study, for once installed the motor element must function dependably, and often continuously, if the

At first sight it might appear to be a problem restricted solely to the motor manufacturer. This is true as far as protective external housings are concerned. Bearings and lubricant seals, however, bring in the bearing designing

engineer and the research authorities of the petroleum industry. All must cooperate thoroughly if the problem is to be successfully solved, and subsequent troubles are to be reduced. As evidence of the active interest which is being shown today, one has but to note the recent organization of an association of bearing engineers and the costly extensions which the outstanding refiners in the petroleum industry have made to research laboratory facilities. The former expect to study in part the standardization of methods of test for petroleum lubricants adaptable to ball and roller bearing service; the latter, in turn, the production of lubricants which will most dependably resist breakdown, oxidation and change in physical characteristics.



Courtesy of The Master Electric Company

Fig 2—The Master geared-head motor, equipped with a unique grease seal of all-metal construction. This effectively retains all lubricant in the housing, and prevents contamination of the lubricant.

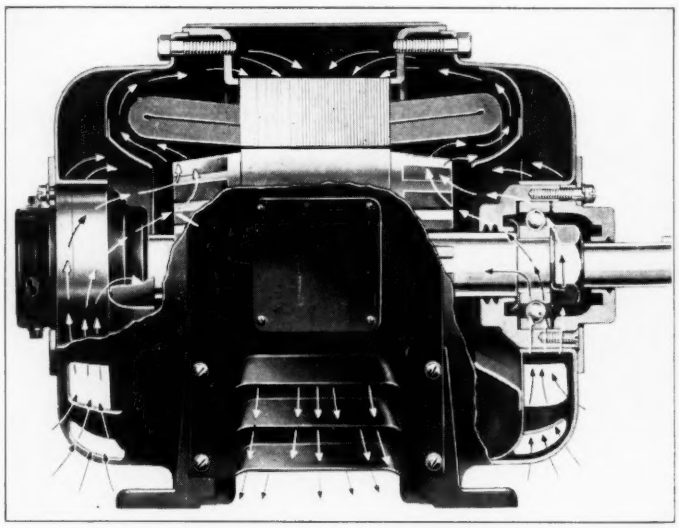
It has, of course, long been possible to obtain bearings of most accurate design, and bearing metals which have passed most exhaustive metallurgical tests. Under normal service conditions it has also been possible to lubricate these successfully and dependably. The advent of the high speed motor drive and the desirability of locating motors in service where hazard and contamination may constantly prevail, has presented this latest problem of improving upon design to assure protection of the rotating parts, the windings and the bearings.

This has brought the designing engineer into the picture more actively than ever before. It has also sponsored the development of a phase of industry dealing almost entirely with construction of bearing seals.

FUNCTION

The essential function of the electric motor as a converter of electrical into mechanical energy is to transmit the power developed by electric generators to producing or materials handling machinery such as grinders, hoists, pumps, machine tools, textile equipment, steel mill machinery, laundry apparatus, etc. In fact, it can be broadly regarded as probably the most generally applied mechanism in modern industry. From the fractional horsepower motor which serves to relieve the drudgery in our homes by operating washing and ironing machines, oil burners, and vacuum cleaners, to the huge reversing equipment required in the modern steel rolling mill, the electric motor is a factor in improving the efficiency of industrial production and reducing the cost and labor of living.

In connection with the application of the electric motor, however, it is well to note its electrical features and to look, for a moment, into the several types of motors available and their adaptability to certain phases of operation. Essentially motors are broadly classified as functioning on direct or alternating current. That is, according to whether the power is constant in its magnitude, polarity, and direction of flow, or whether it alternates repeatedly in polarity varying successively from a maxi-



Courtesy of General Electric Company

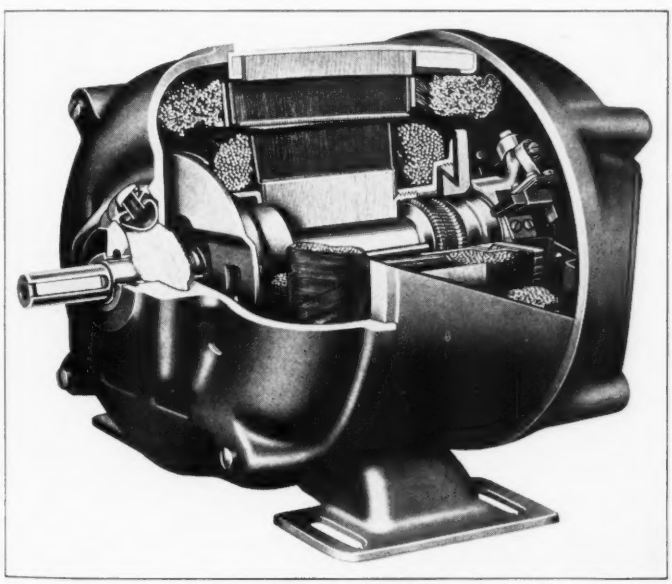
Fig. 3—Showing details of the General Electric splash-proof induction motor. Grease lubricated ball bearings are used on all sizes of these motors. The cartridge type housing excludes water and dirt, yet permits easy disassembly of the motor without exposing the bearings.

mum in one direction to a maximum in the other.

According to the design and service required direct and alternating current motors are in turn known severally as series, shunt or compound wound, as single phase, polyphase, synchronous, or as induction, etc. To the electrical engineer these terms are self-explanatory. Further discussion is unnecessary, for the electrical engineer and motor expert should always be consulted prior to selecting any particular kind of motor for any service. Each has its distinctive advantages for certain types of work. For example, the direct current motor in general is subject to better speed control; this is a factor in the operation of materials handling equipment such as cranes, power shovels, etc. Truck, tractor, hoist and elevator motors, in turn, which must often be started from rest under considerable loads require a high starting torque. Alternating current is advantageous due to the ease, economy and simplicity with which power can be transmitted over relatively long distances.

The induction motor has, in turn, been found to be particularly adaptable to grain elevator service where arcing must be eliminated to reduce the possibility of dust explosions.

From a lubricating point of view, however, electric motors regardless of their type or winding present essentially the same requirements according to the construction of their bearing lubricating systems.

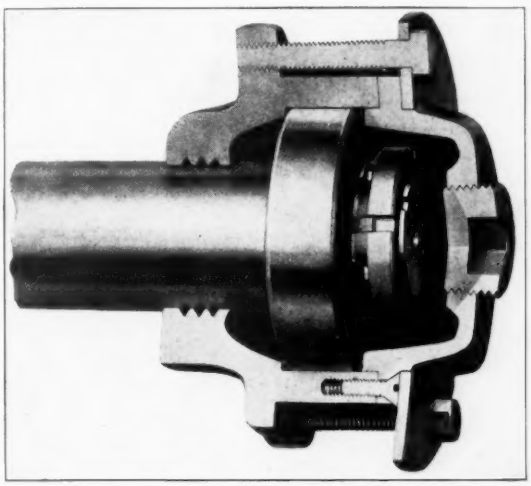


Courtesy of Century Electric Company

Fig. 4—Cut-away view of the Century induction type single phase motor. Note that this is equipped with the Century wool yarn system of lubrication, which assures of extended operation without re-oiling. Filtering properties of the pure wool yarn strands allow only clean oil to be delivered to the bearing surfaces.

CONSTRUCTION

From a constructional point of view an electric motor consists essentially of a frame or stationary element known as a stator, and a revolving armature called the rotor. The former contains a number of field poles suitably wound with wire, the latter is fitted with a series of coils of wire. Delivery of electric current to the poles of the stator brings about rotation of the armature in accordance with the law that a magnetic pole in which an electric current is flowing will attract or repel an electric conductor such as an armature coil, according to the polarity.



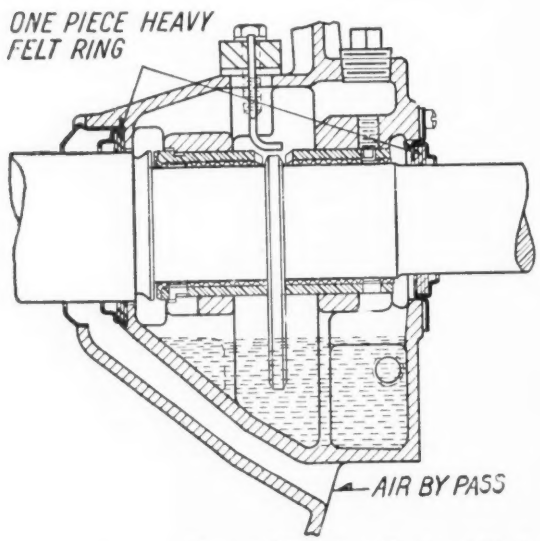
Courtesy of Allis-Chalmers Manufacturing Co.

Fig. 5—Sectional view of the anti-friction bearing cartridge used by Allis-Chalmers. This cartridge consists of a combined sleeve and inner bearing cap, an outer bearing cap, and clamping ring. The outer bearing cap, when attached to the cartridge, completes the bearing closure, thereby keeping the bearing sealed against entrance of dirt and leakage of grease. The clamping ring holds the end cap rigidly against the cartridge and takes any thrust load which may develop.

The rotor, of course, involves a central shaft or journal, which in turn must be carried in suitable bearings located in the stator or frame. These are the only wearing parts of the electric motor wherein lubrication is necessary.

It can be appreciated that the most perfect lubrication is an absolute necessity for efficient motor operation. Any development of abnormal wear of the bearings might very easily cause pounding of the shaft with the possibility of the armature coils coming in contact with the pole pieces of the stator, to cause burnouts. But prior to these extremes, faulty lubrication would be the cause of continued losses in effi-

ciency, due to the natural increase in friction which would most surely result. This would be indicated by increases in bearing temperatures, even if the power capacity of the motor was not materially reduced. As a rule this



Courtesy of Westinghouse Electric and Mfg. Co.

Fig. 6—Showing the Westinghouse sealed sleeve bearing. A heavy cover with a cork gasket is screwed down over the slot through which the oil ring is inserted. A plug closes the inspection hole in the top of the housing and the filler plug has a spring hinge cover which cannot be carried away or lost. This latter prevents accumulated dirt from wicking the oil to the outside. The sealing device around the piston consists of a ring of resilient felt, held in position by special retaining rings.

latter is a serious matter in any plant where motors must be capable of operation at their rated capacity. Any inability to do this work might easily affect production or plant operation to a marked degree.

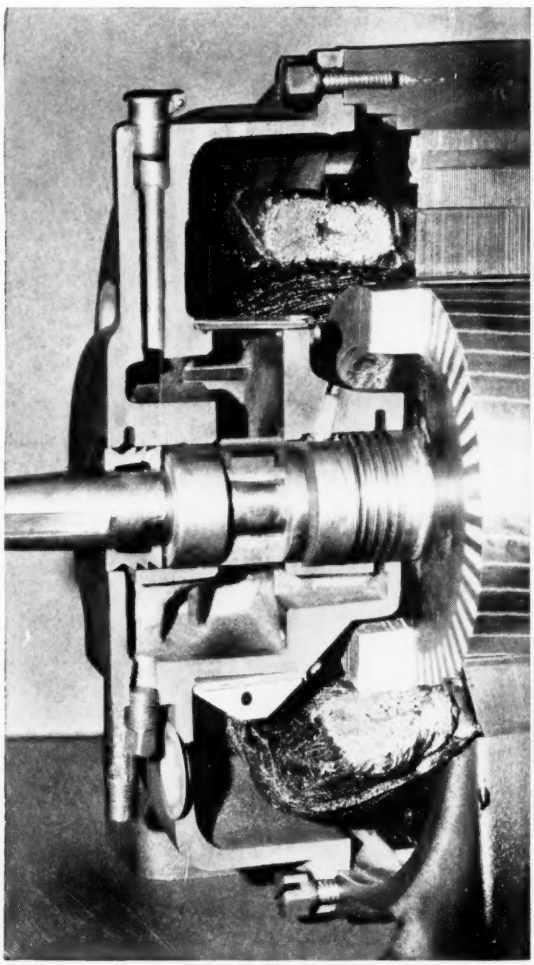
BEARING SEALS

The expected life of any motor bearing, irrespective of its type or design, should be estimated only after due consideration of the provisions for sealing to prevent leakage of lubricant and entry of abrasive dust or dirt, water, or corrosive acids or alkalis. Dependent upon the type of service, a variety of seals have been developed including felt and cork washers or gaskets, metallic slingers, dust collars, expanding rawhide devices, grease-filled grooves or various combinations of these. One authority,* however, aptly stressed the fact that "sealed housings . . . are but one factor of securing long bearing life. That of keeping the bearing surfaces thoroughly lubricated at all times is of still greater importance. Other factors, such as use of the proper grade of oil, occasional inspection and proper motor application are at the mercy of the user."

Motor builders early appreciated that retention of lubricant was most important. Later, as applications were extended to heavy duty service and conditions severely detrimental both to lubrication and motor windings, further thought was given to improvement in design. The modern splash-proof motor is the result of this research.

Obviously, protection of the surfaces of the bearing elements could not be assured were leakage of lubricants to prevail, and with this lack of protection, failure of a bearing under intense load might easily occur.

In conjunction with this study of sealing devices, high temperatures also had to be



Courtesy of Crocker Wheeler Electric Manufacturing Co.

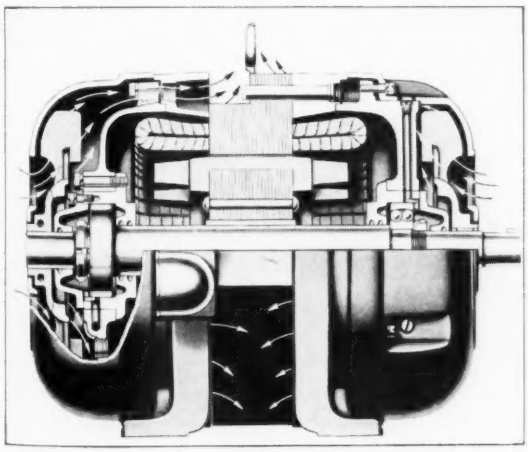
Fig. 7—Showing a Crocker Wheeler wool packed bearing. There is no leakage from either end when the motor is in operation. Oil that is added flows directly to the bottom of the reservoir and wool sucks up only clean oil to the bearing. A novel design of seal prevents entry of contaminating matter and assures of complete lubrication durability, long life and efficiency.

considered, especially for motors designed for steel mill, stoker and economizer service. The effect of high temperature is to reduce the viscosity or consistency of any lubricant. The extent to which this will occur depends of course

* Wagner Electric Corporation.

upon the original body of the product. Unless the latter is of the nature of steam cylinder oil with a viscosity in the neighborhood of 130 seconds Saybolt or above, at 210 degrees Fahr., at steel mill temperatures considerable leakage may result from certain types of bearings. It is for this reason that steam cylinder stocks are used in certain grades of high temperature ball and roller bearing greases. With a lubricant of this nature, plus a suitable bearing seal, leakage, even under extreme temperatures, can be prevented to a marked degree.

In this connection, a discussion of the various types of seal design will be of particular interest. When sealing methods were first developed, felt and leather washer and grease-groove seals proved their adaptability and were comparatively inexpensive and simple in design. By virtue of these advantages, they are still retained by many bearing manufacturers. Since their development, however, other types of seals have come into usage including metallic rings similar to piston rings, mercury baths in connection with vertical installations, and metallic springs for the purpose of maintaining the adjustment of felt, leather, rawhide and cork with respect to the rotating element. Composition rings of micarta or Bakelite have also proved of value as an oil seal, or to protect a grease-lubricated bearing against entry of water. Vertical motor installations have called for considerable study of sealing devices. Fortunately, the ball bearing

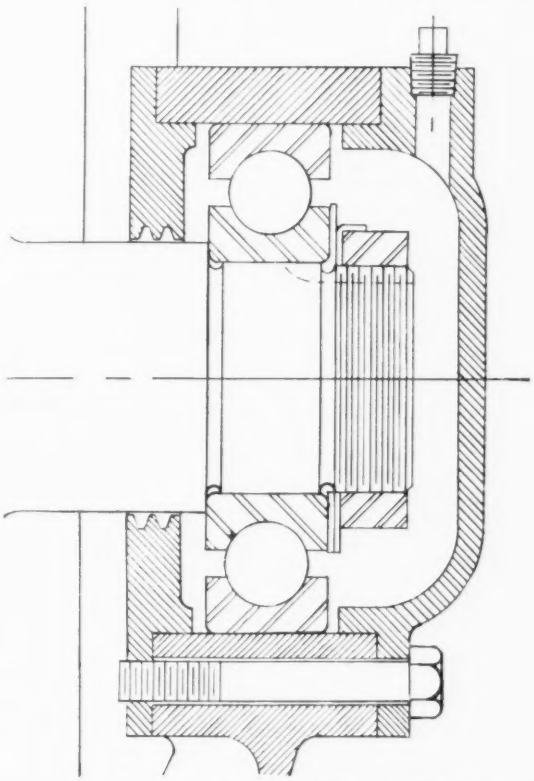


Courtesy of Fairbanks, Morse and Co.

Fig. 8—Sectional view showing the compact construction made possible by use of ball bearings on the Fairbanks Morse totally enclosed, fan cooled motor. These bearings are mounted in sealed cartridge type housings. Arrows show path of cooling air which is circulated by the large cast-iron fans at both ends of the motor.

has proved to be particularly adaptable to such motors. With the added feature of dependability under high speeds and intensive thrust loads, this type of bearing has gained considerable favor.

Any bearing seal, to be most effective, must show practically no wear in service; otherwise, the purpose may be more or less defeated. Washer type seals may consequently be unsatisfactory in this regard, although the rate



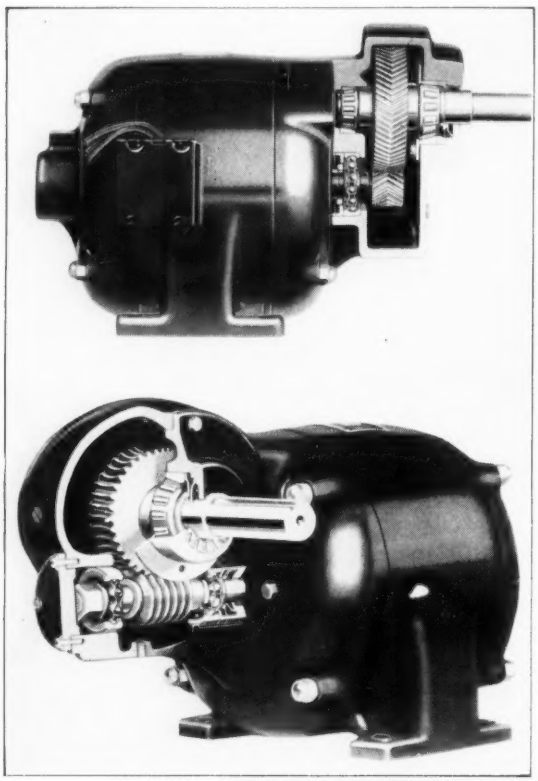
Courtesy of The Lincoln Electric Company

Fig. 9—Showing general assembly of the Lincoln ball bearing type motor bearing. This bearing is provided with suitable grooves to enable use of a grease seal. Where care is used in selecting a suitable grade of grease the possibility of heating or wear of the shaft will be reduced and the grease will be capable of maintaining an adequate seal under all usual conditions of operation. The grease must be only plastic enough to form a collar around the shaft and maintain that shape, inasmuch as this property will most effectively prevent entry of dust and dirt.

of wear will depend upon the quality of the material. This is one reason why adjusting springs are used today in connection with washer or leather cup seals, to keep the material in close contact with the shaft or journal surface, and thereby compensate for wear and enable dependable retention of lubricant.

Leakage of lighter lubricants under normal temperature conditions can often be prevented by grease groove seals. They are also relatively simple and inexpensive to design. On the other hand, they require attention at periodic intervals, for the purpose of renewing the sealing grease. Otherwise, possible glazing of the surface of this latter where it comes in contact with the rotating shaft might result in sufficient clearance to allow leakage of the bearing lubricant. Very heavy bodied greases of high

melting point are adaptable to service as grease seals, provided they show no tendency to separate oil from soap, and contain no material which might prove abrasive to the shaft surface. Grease grooves can also be used together



Courtesy of The Master Electric Company

Fig. 10—Showing The Master right-angle and parallel shaft geared-head motor and bearing details. These bearings are provided with the standard Master type of grease seal of all-metal construction, which effectively retains lubricant and prevents entry of contaminating foreign matter.

with felt washers in certain types of service, although this may require extension of the length of the bearing housing.

The spring adjusted seal is frequently claimed to insure most uniform contact with and conformation to the surface of the rotor shaft. It is extensively applied to rawhide or cup leather seals when most positive sealing is essential and where first cost should be of secondary consideration. This type of seal is well suited to the ball or roller bearing, where use of a minimum amount of housing space is advantageous. It is an especially good seal in the presence of moisture, also, where abrasive dust or metallic particles must be kept out of the bearings.

Class of Service

The service to which the housed or enclosed motor is being applied will be of interest. The higher speed type of design is adaptable to machine tools, textile equipment, shoe machinery, airplane beacon drives, and vacuum cleaning machinery. The sealed housing type of motor, in turn, has found an extensive field of application in dairy, meat packing, grain elevator, cement mill, brewery, stone cutting and laundry service.

The effect of high speed is to increase windage and possible drawing in of abrasive materials through both the bearings and ventilating apertures. High shaft speeds also place a severe load upon the lubricant in its protection of the bearings by reason of development of higher temperatures. As temperatures increase, it is obvious that the lubricant used must be more resistant to breakdown and formation of gummy, resinous or carbonaceous deposits. In the sleeve type bearing these would tend to accumulate in the oil grooves to interfere with proper circulation of the lubricant. In a ball or roller bearing they would gather in the raceways or cages to impose a braking action upon free rotation of the rolling elements.

More recently, with the introduction of the geared motor, it has also been necessary to consider the possible effect of windage and dust contamination upon the gear lubricant. The geared motor is an especially valuable means of combining the driving and speed reducing elements in one compact housing which can be effectively designed to withstand entry of contaminating foreign matter. It is advantageous where economy of space is essential, and where installation must be made in hazardous or cramped localities.

Adaptability to Existing Installations

Motor builders have appreciated the advantage of so designing their seal type bearings as to render them adaptable to standard types of housings. There is obviously an economical advantage to a bearing of this nature, in that it enables the operator to locate or move the motor around in his plant according to power requirements or production demands. Where a sealed type of bearing may be necessary, if he can install same with but little trouble it should react to the marked benefit of all concerned. Any movement to facilitate such a procedure will always be appreciated by the lubricating engineer, for he is immediately assured of better performance of his lubricants, and relieved of the possibility of explaining failures which so often are not due to faulty lubrication.

Interchangeability of either sleeve-type or anti-friction bearings can be more readily assured by providing for same at the time of designing the motor, although it is perfectly feasible to make changes later, especially when new bearings are being considered. In any

event, it is important to remember that certain types of bearing seals may require increase in length of the housing. This may in part offset one of the advantages claimed, particularly for the ball bearing, that over-all length is reduced and yet, protection of bearing elements against undue wear by more positive lubrication should be of far more importance.

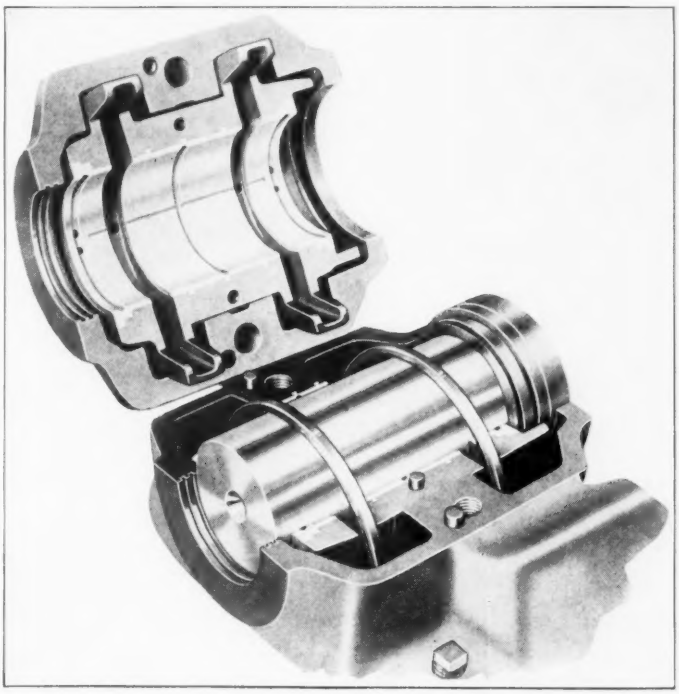
In the sleeve type bearing provided for oil lubrication by means of ring oilers a sealed vapor and spray chamber at each end of the bearing, as shown in Fig. 12 will function to retain oil vapor and spray which may be thrown off by the oil rings. Due provision to return this oil to the reservoir in the base of the bearing is of particular advantage in maintaining economy and cleanliness.

In some conventional types of sleeve bearings where oil is thrown directly onto the walls of the housing, obviously more or less leakage may occur for some oil will always creep along the shaft to work its way out through any seal that may be provided. Very often in such bearings there is no seal, in which event leakage might easily become very objectionable. Where such bearings are grease lubricated a collar of grease penetrating from the bearing around the shaft has often been regarded as an indication of adequate lubrication. Furthermore, it will often effectively prevent dust, dirt or foreign matter from working into the bearing clearance space. On the other hand, any lubricant present elsewhere than in the lubricating system may very easily develop a hazardous or sloppy condition which frequently is more detrimental than beneficial. The answer is, therefore, more attention to bearing design and adoption of sealing devices which will positively keep the lubricant where it belongs, and prevent entry of foreign matter.

Housing of Fractional Horsepower Motor Bearings

The trend in motor design, where high speed units of fractional horsepower are involved, for household electrical equipment in particular, is to adopt the ball bearing. A unique problem has presented itself, in that initial lubrication must be so positive as to warrant no renewal of lubricant for months or even years. The ideal of the motor builder is to obtain a design and a type of lubricant which will function over the life of the machine. To date, however, although research progress has been intensive, no type of bearing or grade of lubricant has been developed which one might assume to be entirely free from potential trouble if re-lubrication is absolutely neglected.

The petroleum industry is particularly interested in this trend of design toward relieving the operators of all thought of lubrication, and it is quite reasonable to expect that methods of refinement and compounding will develop a type of grease which will strongly resist any tendency toward oxidation, separation, solubility or acid or alkali development. It is a field for the grease chemist, but it requires the absolute cooperation of bearing manufacturers and the electric motor builders. Both must tolerate moderate advancement, and be prepared to compromise with the grease chemist as research proceeds. Only in this way can best results be accomplished. Any unreasonable attitude toward methods of test, specification of materials or the imposing of virtually impossible operating or test conditions will only delay progress and create hard feeling.



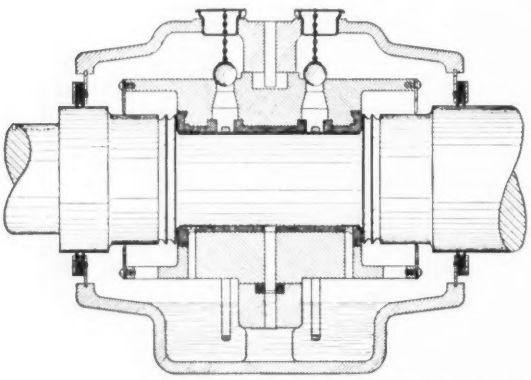
Courtesy of Wagner Electric Corporation

Fig. 11—Exposed view of the Wagner split type ring-oiled motor bearing. End grooves are provided in the bearings just beyond the ring channels, for the purpose of trapping excess oil and leading it to the well through drain holes in the bottom of the grooves. Vent holes at the top of these grooves facilitate flow of oil through the oil holes at the bottom. The top side of the bearing is provided with lateral and center oil grooves to enable uniform oil distribution. A dust cap is also provided for sealing the end of the housing against oil leakage, or entry of dirt.

WICK AND WOOL YARN OILING SYSTEMS

Where fractional horsepower motors are not subjected to abnormally high speeds, that is, speeds above 3600 r.p.m., considerable economy

has also been attained by employing sleeve type bearings with provision for oil lubrication by means of wick feed or the capillary action of wool yarn. Oil lubrication is especially advantageous where it can be positively maintained, due to decrease in the possibility of oxidation, development of acidity or gummy formations. Naturally the oil must be protected against contamination. For long periods of time in average household service the wick or wool yarn will serve as an admirable filter. Ultimately, however, renewal or cleansing should be done. The principles of design and operation of such systems will be of particular interest to the owners of this type of motor, as applied to household washing machines and refrigerators, oil burners, house pumps, etc. One of the most common wick lubricating systems involves an oil cup underneath the motor bearing containing a felt or candle-wick which is pressed upward against the shaft with a spring. In another, holes drilled in the casting contain the wick. Still another type involves a comparatively long felt wick placed at the side of the bearing attached to the shaft through a hole cut in the side of the bearing sleeve. The wick housing is open at top and bottom, it being intended that the only oil in reserve will be that held in the felt by capillary attraction.



Courtesy of Allis-Chalmers Manufacturing Co.

Fig. 12—Showing section through center of the improved type of Allis Chalmers ring oiled bearing. It will be noted that there is a sealed vapor and spray chamber provided in the bushing at each end of the journal, which catches vapor and spray thrown off from the oil slingers, to collect it and lead it to the reservoir in the housing. Sheet brass seals at the ends of the bushing have very close clearances between their inner edges and the shaft, in order to prevent oil vapor from being carried out by air currents.

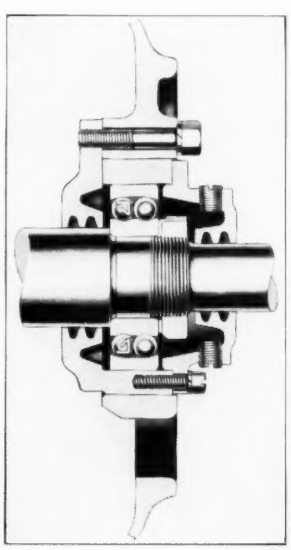
These might be termed "up-feed" types of lubrication, due to the fact that the flow of oil is upward through the pores of the wick of its own accord, the motion of the shaft or journal being required to draw the oil away from the uppermost portion of the wick with which it is in contact. These types of wick feed oilers are automatic in that the oiling stops and starts with the stopping and starting of the shaft or journal on the armature. Therefore, there is no chance of waste of oil during shut-down periods. Yet the wick is ready for immediate service as long as there is oil in the oil cup or the wick remains saturated.

In such bearings, as a rule, the viscosity of the oil used should be from 200 to 300 seconds Saybolt at 100 degrees Fahr. Such oil should always have as low a pour test as possible to meet low temperature conditions wherever necessary, which is quite frequent when the motors are operating small pumps for house or farm supplies, garage air compressors, etc.

Waste Packed and Wool Yarn Systems

Other types of motors of the fractional horsepower variety may be equipped with the so-called waste packed and wool yarn system of lubrication. Such systems consist generally of oil wells and bearing housings practically the same as supplied for the ring oiler system of lubrication, to provide an ample reservoir for the oil.

The effectiveness of the waste packed bearing depends upon careful packing of the bearing so that the pressure of the waste will insure its continued contact with the shaft or journal through one or more slots cut in the bearing sleeve. This may be on the top, sides or bottom of the latter.



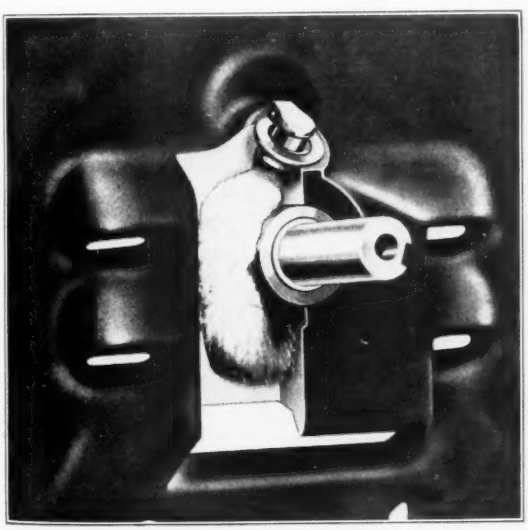
Courtesy of Fairbanks, Morse and Company

Fig. 13—Cutaway view of the self-aligning double-row seal ball bearing carried in cartridge type of mounting employed by Fairbanks Morse for their squirrel cage induction motors. This permits of removal of the rotor without exposing the bearings to dust or corrosive gases which may be present. The type of housing used is dust-tight and clean bearings are therefore assured.

In the wool yarn system of lubrication

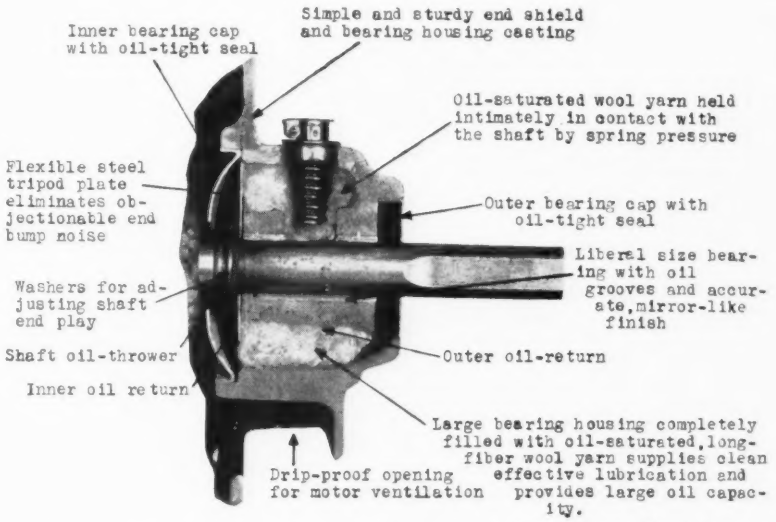
certain advantages brought out by Century Electric Company for fractional horsepower motors are of decided interest, viz.:

1. The strands of wool yarn lay across the shaft in a slot in the bearing sleeve such as is usually provided for a ring oiler, the long ends of the yarn being packed down into the oil well.
2. The strands of wool yarn being continuous and unbroken, permit capillary action to assert itself completely. Under heavy bearing pressures this system has shown itself in thousands of cases in regular service applications, to be the equal of any lubrication method in keeping down bearing wear and temperature in fractional horsepower motors.
3. Because of capillary activity and the filtering properties of pure wool yarn, all oil is completely filtered through the yarn fibre before delivery to the bearing surface.
4. Wool yarn lubrication eliminates all tendency of oil bubbling—no possibility of clogging up the oil returns to the oil well.
5. The use of the wool yarn system of lubrication eliminates the danger from leaks from an oil well, since the wool yarn itself will hold in suspension sufficient oil properly to lubricate a fractional h.p. motor for at least one year's continuous 24-hour-per-day operation.
6. It increases the total capacity of the small motor ring oiler type of oil well about 100 per cent, due to the additional oil held in suspense in the yarn.
7. Positive lubrication under all conditions, even at extremely low room temperature.
8. Long-time service without re-oiling is assured by the above factors.



Courtesy of Century Electric Company

Fig. 14—Showing the Century system of wool yarn lubrication, as applied to electric motors which must function for a considerable length of time without re-lubrication.



Courtesy of General Electric Company

Fig. 15—Showing the type of bearing construction employed by the General Electric Company for fractional horsepower motors. All parts are clearly indicated

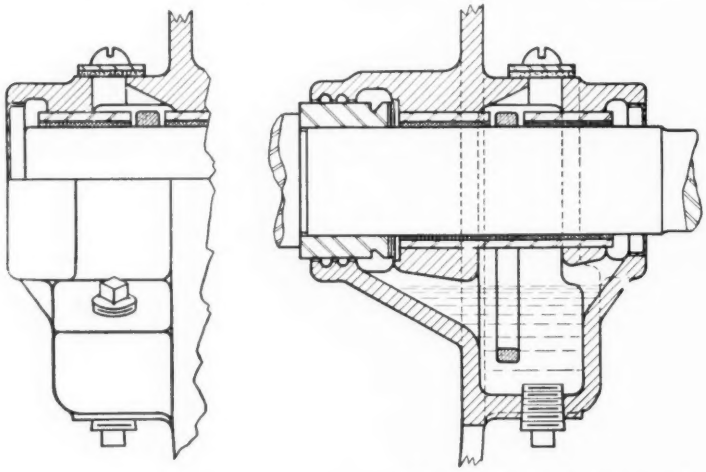
Such bearings, as a rule, will also require an oil of from 200 to 300 seconds Saybolt viscosity at 100 degrees Fahr. The oil should always have as low a pour test as possible to meet low temperature conditions wherever necessary, which may be quite frequent.

DRAINING AND VENTING

In view of the fact that lubrication of any motor bearing can only be as satisfactory as the purity of the lubricant used, there must be adequate provision for draining and flushing of the bearing at periodic intervals, and suitable venting during operation to enable relief of back pressure upon the lubricant. One can realize that continued churning of abrasive foreign matter with oil or grease in any motor bearing, and its passage through plain bearing clearance spaces or in intimate contact with

highly polished balls, rollers or raceways, will lead to abnormal wear, noise, misalignment, and usually the necessity for costly repairs.

With the increased preference for the ball bearing in certain types of motors of low to medium power capacity, the frequency and even the necessity for draining and flushing is often a subject of discussion. Where bearings are fitted with a sealing arrangement which has definitely proved an ability to prevent entry of contaminating foreign matter, it is obvious that draining and flushing periods can be materially extended. Under comparatively clean operating conditions it is reasonable to presume that some motor bearings can function for years without flushing.



Courtesy of Wagner Electric Corporation

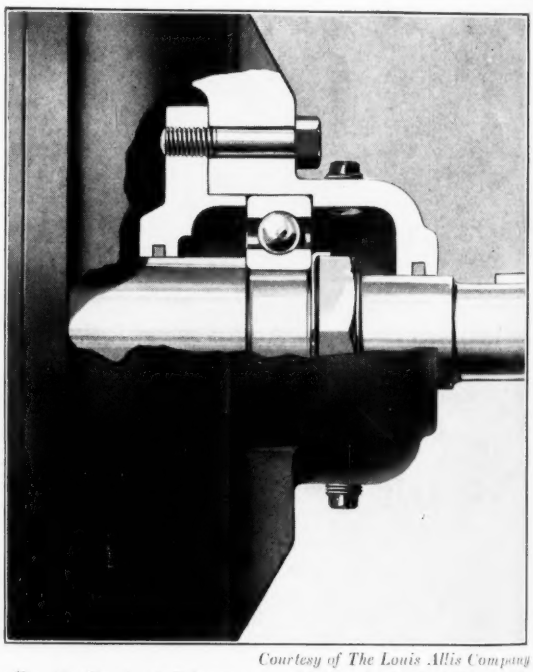
Fig. 16—Details of the Wagner sleeve-type ring-oiled motor bearing. Every precaution has been taken to render this construction dust-proof by installing sealed grooves and a thrust collar with oil slinger. This latter also makes it impossible for oil to pass into the motor. A dust collar is also provided at the drive end to prevent entry of dirt.

On the other hand, to set any hard and fast rule, even with the best of seals, would be unwise, due to the wide variety of service to which motors must be subjected, particularly in industrial or power plants. For this reason suitable provision is usually made for drainage of lubricant and flushing oil, by locating an outlet in the base of each bearing.

Normally a suitable plug which can be securely screwed into a drilled and tapped hole will serve the purpose and prevent leakage during operation. Oftentimes this can be elaborated upon where oil is employed for lubrication by an arrangement of nipples and pipe fittings terminating in a sight gauge glass. This facilitates not only cleaning but also observation of the oil level in the bearing.

Oil lubricated sleeve-type bearings should be gauged regularly for oil level in the reservoirs, and only the amount of oil necessary to bring the level to the proper height should be added. In the railway motor, should gauging show that very little oil has been fed since the last inspection, there is good reason to believe that the hole at the bottom between the two wells is plugged and it should be cleaned before oil is added. If the hole is kept open, all oil should be added through the oil well rather than to the top of the waste. Some dust is bound to get into the waste, and adding the oil on top washes the dust down to the bearing. If evidence of water is found in the waste, the latter should be removed and the bearing packed with new waste as water tends to emulsify with the impurities present, thus glazing the waste at the shaft, and reducing its ability to hold and deliver oil to the shaft surface.

Maximum protection of a ball or roller bearing requires positive assurance that the lubricating system is as free from foreign matter as possible. In certain types of operation this can be more easily accomplished than in others; the extent to which dust, dirt, metallic chips or scale may be present in the air or thrown on to any bearing will, of course, be an influencing factor.



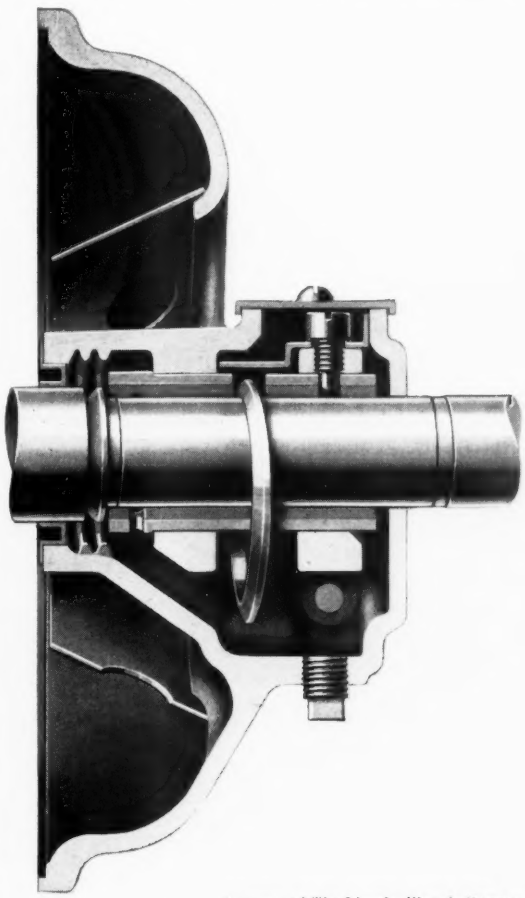
Courtesy of The Louis Allis Company

Fig. 17—Showing ball bearing assembly for the Louis Allis wound-rotor induction motor. Note that on the outboard end a felt seal is provided to exclude dust and dirt. Note also drain plug at base of the bearing housing.

In steel mill, cement plant, grain elevator

and flour mill service this may be especially serious. In the application of anti-friction bearing seals as well as provisions for cleaning there is always possibility of entry of non-lubricating abrasive impurities where motor bearings are not properly sealed. The detrimental results which would develop in the form of scored bearing elements, misalignment, and the necessity for bearing replacement, with the attendant effect upon production are entirely obvious. In fact, the most intensive duty to which such a bearing can be subjected is continued churning of abrasive foreign matter with oil or grease in intimate contact with the highly polished rolling elements and raceways.

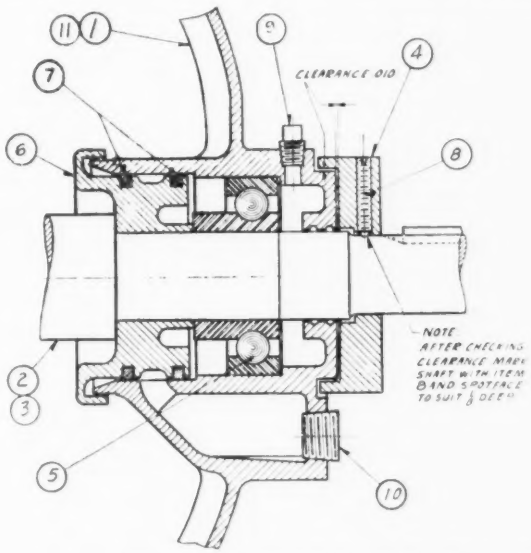
Inasmuch as it is not always possible to



Courtesy of The Lincoln Electric Company

Fig. 18—Showing the sleeve type bearing with ring oiler as used on certain types of Lincoln motors. Comparative size of the oil reservoir with respect to the ring is clearly shown; also means provided for retaining oil in the circulating system and excluding entry of contaminating foreign matter.

effect the requisite degree of sealing or to depend upon the seal being in proper condition at all times, motor bearings which may be exposed to excessive abrasive or non-lubricating materials should be flushed and cleaned at periodic intervals. The frequency, of course, will depend upon the design of the bearing, the type of seal, the extent to which dust, dirt, scale or water may be present, and the nature of the lubricant. Some classes of steel or paper



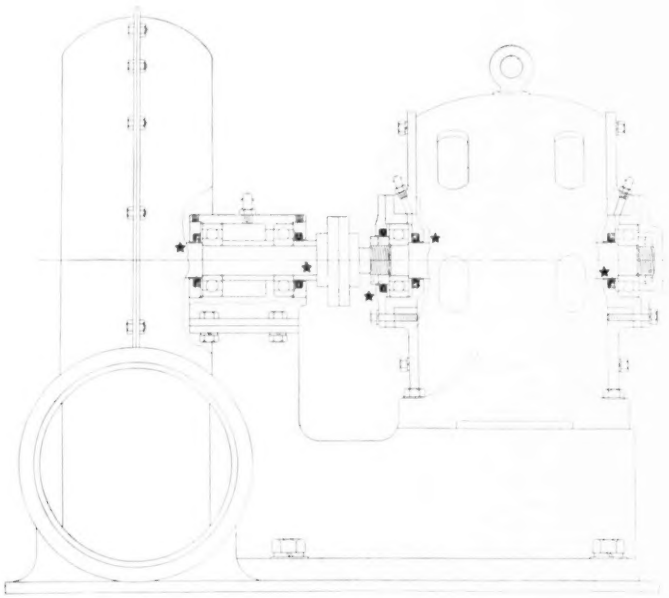
Courtesy of Westinghouse Electric and Manufacturing Co.

Fig. 19—Details of a Westinghouse ball bearing motor assembly, showing at, 4 the bearing cap; 5, the ball bearing; 6, the ring retainer; 7, piston ring type seals; 9, pipe plug in filling hole; and 10, pipe plug in drainage hole.

mill service will be more subject to contamination of lubricants than others. Some types of bearing seals will also be more effective than others. Yet, even with such precautions, cleaning of the bearings should not be neglected, for experience has proved that their life can be materially lengthened by such attention. Cleaning can be most effectively accomplished by flushing with a light oil. Solvents are not advisable, especially when greases have been used, due to the possibility of non-soluble soap residues remaining within the housing after their oil content has gone into solution.

Ring oiling systems will in general require more frequent attention than ball or roller bearings, due to the fact that their housings are often less carefully designed. With the former cleaning may be necessary or advisable at periods ranging from every two weeks to every several months; whereas in normal service a properly sealed ball or roller bearing may function indefinitely, unless operating conditions are especially dirty. On the other hand, such bearings are more delicate from the viewpoint of construction, and therefore oil or grease should not be allowed to become as contaminated as is permissible with other types of bearings. Wherever grease lubricated ball or roller bearings are involved, and drainage

cannot be readily carried out, due perhaps to the body or consistency of the lubricant, the grease should be wiped out thoroughly at the period of cleaning; flushing of such lubricants is generally not an entirely satisfactory procedure.



Courtesy of The Chicago Rawhide Mfg. Co.

Fig. 20—A motor driven exhauster, equipped with ball bearings, to which Chicago Rawhide seals are applied as indicated by stars, for the purpose of preventing loss of grease and entry of contaminating foreign matter.

Ring oiling systems possess natural advantages in that the flood of oil which is constantly passing through the bearings tends to wash out any grit, dirt, dust, or metallic particles that may have gained entry. As a result, wear is reduced to a minimum, just as long as the oil in the system does not become so highly contaminated as to be unable to precipitate such foreign matter during its period of so-called rest. This flooding of bearings, by virtue of its washing action, naturally gives rise to gradual accumulation of foreign matter, therefore the condition of the oil should be carefully watched, and the system drained immediately any excess of dirt becomes apparent.

Conclusion

To those who are interested in machine design and the correlation of methods of lubrication with operating requirements, analysis of the electric motor becomes a fascinating study. Frequently it is passed over entirely too casually, largely on account of its ability to function so often under conditions which would severely tax many other types of machinery. Credit is due to the designer in this regard, for his realization of:

The limitations of the prevailing systems of lubrication

The effect of operating conditions

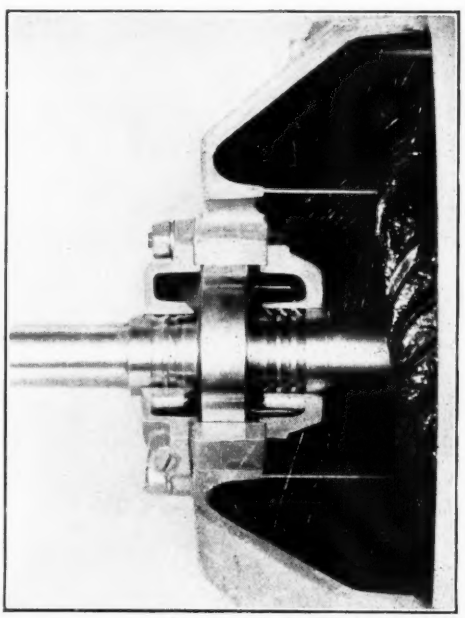
The necessity for study of the lubricating ability of oils and greases, and

The comparative advantages of different types of bearings and bearing seals for various operations.

It is obvious that thorough understanding of these details will also be of assistance in selection of motors as well as lubricants for their subsequent lubrication.

The electric motor is probably the most widely used mechanism in modern industry. Provided its bearings are properly lubricated, it is an amazingly gratifying machine to operate, for it rarely fails to meet production demands and justify its installation. It is, therefore, worthy of every consideration, and the highest quality lubricants available.

A dollars and cents viewpoint is the most forcible way of emphasizing the advantages of effective lubrication and, particularly in the electric motor, selection of the right lubricant is assurance of price return many times over.



Courtesy of Crocker Wheeler Electric Mfg. Co.

Fig. 21.—Known as the any-position ball bearing mounting for general purpose motors. This design of Crocker Wheeler has a patented seal that, with shaft at any angle and with the lightest of fluid greases, is claimed to prevent leakage of grease, entry of foreign matter, and loss of power through internal or shaft friction.

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TEXACO LUBRICATION RECOMMENDATIONS

for ELECTRIC MOTORS

RING OILED, BALL AND ROLLER BEARINGS
WICK OR WOOL-YARN TYPES

RING OILERS

Normal Temperatures	TEXACO REGAL OIL B TEXACO CANOPUS OIL OR TEXACO NABOB OIL
Low Temperatures	TEXACO CETUS OIL OR TEXACO CAPELLA OIL
High Temperatures	TEXACO ALCAID OR ALGOL OIL, OR TEXACO ALEPH OR ALTAIR OIL

BALL AND ROLLER BEARINGS

Oil Lubricated

Where Housings are Oil-tight, Operating Conditions Normal and Speeds High	TEXACO SPICA OIL TEXACO CETUS OIL, OR TEXACO REGAL OIL B
For Roller Bearings where End Thrust is Appreciable; and Ball Bearings under Low Speeds and Higher Temperatures	TEXACO ALCAID OIL TEXACO ALGOL OIL, OR TEXACO TEXOLS
For Roller Bearings Operating under Extreme Temperature and Pressure	TEXACO URSA OIL TEXACO PINNACLE MINERAL CYLINDER OIL

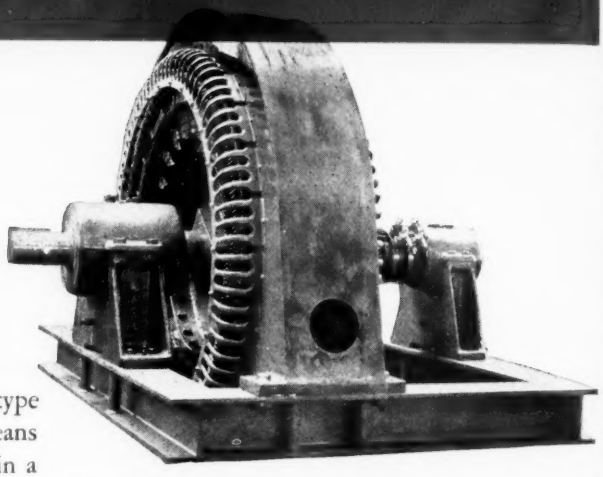
Grease Lubricated

According to Type and Construction of the Bearing, Operating Pressures and Temperatures	TEXACO STAR GREASES TEXACO MARFAK GREASES, OR TEXACO STAR H GREASE No. 00 OR No. 1

WICK OR WOOL-YARN SYSTEMS

Industrial Motors	TEXACO CANOPUS OIL TEXACO CETUS OIL, OR TEXACO CANOPUS OIL D
Electric Street Railway Motors (According to Operating Temperatures)	TEXACO ELECTRIC CAR OIL SUMMER OR TEXACO ELECTRIC CAR OIL WINTER

OF THE MANY AND VARIED TEXACO ELECTRIC MOTOR LUBRICANTS, ONE *will give Better Service on this motor than any of the others*



HERE is an electric motor with sleeve type bearings, lubrication of which is provided by means of ring oilers. When the motor is to operate in a steel mill (where temperatures are abnormally high) ideal lubricating effectiveness is obtained by the use of Texaco Algol Oil.

The same motor operating under low temperatures (as in an ice plant) would give most effective service if lubricated with Texaco Cetus Oil.

It is not possible within the space here available to give specific lubrication recommendations for all the different types of electric motors. As the recommendations on the preceding page show, many factors must be taken into consideration: Whether the bearings are ring oiled, ball or roller type, wick or wool-yarn lubricated—whether the temperatures are high, low or normal—whether oil or grease lubricated.

For each type there is a Texaco Lubricant that will give most effective bearing protection—that has the proper characteristics to resist breakdown, reduce the formation of gummy, resinous and carbonaceous deposits (which eventually mean wear)—that has the body to prevent leakage under high temperatures and which will remain fluid under low temperatures.

Any of the Texaco Lubricants indicated on the preceding page, if applied according to our recommendations, will assure the longest life of effective usefulness for your electric motors.

Plant operators are welcome to call on The Texas Company for any assistance whatever in the matter of electric motor lubrication, whether the problem concerns the lubrication of a fractional horse-power motor or an entire plant assemblage.

THE TEXAS COMPANY

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